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Performance Targets for IAEA Detection of Undeclared Nuclear Activities

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ABSTRACT

Under the state-level concept (SLC), the IAEA identifies for each state a set of possible acquisition paths by which the state could acquire nuclear material for use in a nuclear explosive if, hypothetically, it were to take a decision to do so. To detect such acquisition, the Agency identifies three generic state-level objectives: to detect undeclared nuclear material or activities anywhere in the state; to detect undeclared production or processing of nuclear material in declared nuclear facilities; and to detect diversion of declared nuclear material. When these generic goals are applied at a specific step in an acquisition path, they lead to state-specific technical objectives. As a benchmark of effectiveness, IAEA Safeguards Department officials have suggested the concept of incorporating a performance target for each technical objective under its guidance for implementing the SLC. For technical objectives relating to detection of undeclared activities, however, setting performance targets presents certain challenges. The set of possible undeclared activities an adversary could undertake is large, and the likelihood of detection depends not only on IAEA efforts but also on information from open sources or third parties. A direct causal link between IAEA activities and detection probability would be difficult to formulate, and this affects the nature of the assurances the Agency can provide.

This paper will suggest how performance targets for detecting undeclared activities might be formulated, consistent with the Agency's important role in detecting, investigating, and deterring such activities. Targets would specify what should be done, rather than what detection probability should be achieved. One overarching goal would be to maintain a consistent model of the state's nuclear and nuclear-related activities and capabilities. Another target, for example, might be to conduct adequate open-source collection and analysis, including broad collection and review as well as focused research and analysis on any priority topics identified in acquisition path analysis. Taking steps to resolve questions and inconsistencies arising from such analysis would be another important performance target.

1. INTRODUCTION

Under the International Atomic Energy Agency's state-level concept (SLC) for safeguards implementation, the Agency identifies for each state a set of possible acquisition paths; that is, it identifies steps the state could take to pursue acquisition of nuclear material for the development of a nuclear weapon or other nuclear explosive device. To detect and deter such acquisition the Agency identifies three generic state-level objectives for safeguards:

- Objective A: To detect any undeclared nuclear material or activities in the state as a whole
- Objective B: To detect any undeclared production or processing of nuclear material in declared facilities or locations outside facilities (LOFs) where nuclear material is customarily used
- Objective C: To detect diversion of declared nuclear material

When these generic goals are applied to detection of a specific step in an acquisition path (for example, detection of the misuse of a declared enrichment plant to produce undeclared high-enriched uranium), it leads to state-specific *technical objectives*. In a 2011 conference paper on the SLC,¹ IAEA authors introduced the concept of a *performance target* for a technical objective, as a benchmark of effectiveness:

“For each State-specific technical objective, performance targets will be established that ensure that the planned safeguards measures achieve the generic safeguards objectives. The performance targets for the diversion-related objectives may include State-specific timeliness goals, quantity goals, and detection probabilities.”

The Agency has also addressed performance targets in its series of Technical Meetings for IAEA Member States on the SLC.

A recent report² by authors at Brookhaven National Laboratory offered suggestions on how such performance targets might work for technical objectives of type “B” (detection of misuse of declared facilities) and type “C” (detection of diversion of declared nuclear material). As described in that paper, the “performance target” for a given technical objective would take the form of guidance that would:

- define clearly what the technical objective is, and
- show how to determine whether a specific set of safeguards measures would, if carried out, meet the state-specific technical objective.

Type B and type C technical objectives would be characterized in terms of quantity and timeliness parameters where appropriate. The effectiveness target values for the safeguards measures (or combinations thereof) would be designated as “Low”, “Medium” and “High.” The idea would be to model a relationship between safeguards activities and a likelihood of detection. As part of the process of formulating an Annual Implementation Plan (AIP) and State Level Approach (SLA), performance targets would serve to logically link the specific safeguards activities to safeguards objectives, and to select and justify activities chosen. Performance targets could also serve as a basis for evaluating the effectiveness of safeguards implementation.

Performance Targets for Objective A

Setting performance targets is more challenging for type A technical objectives, i.e., for detection of undeclared nuclear materials and undeclared nuclear activities in the state as a whole. As noted in the Brookhaven paper, the IAEA must still undertake efforts to fulfill those objectives, but it is much harder to model a causal relationship between

safeguards activities and detection outcomes. Thus, a performance target for type A technical objectives would have to have a different type of content than performance targets for technical objectives related to diversion or misuse. In the case of undeclared activities, the set of possible activities that an adversary could undertake, and the possible ways in which they could be undertaken, is very large. Moreover, the likelihood of detection may depend not only on activities undertaken by the IAEA, but also on information from other sources (e.g., information from open sources or third parties). Therefore, the nature and level of assurances the Agency can provide is different from the case of declared facilities and should be treated as such.

This paper describes how performance targets for technical objectives of type A might be formulated. Because a direct causal link between Agency activities and detection capability is hard to formulate “scientifically,” the nature and intensity of safeguards activities that are to be undertaken to detect undeclared activities has to be determined in large part as a matter of policy. So the approach taken here is to postulate such a policy and show how one could establish performance targets that would require those safeguards activities. The paper then suggests how assessments of safeguards measures related to undeclared activities could be used in the context of acquisition path analysis, and their impacts on safeguards at declared locations.

Basically, the approach tries to follow a fairly simple philosophy: the Agency should play an important, although realistically bounded, role in detecting and deterring undeclared activities; it should therefore be able to effectively perform certain activities, and should maintain certain capabilities and apply them as part of an overall state-level safeguards approach. In states with an Additional Protocol (AP) in force, provided these activities are conducted and these capabilities exist, there should be some credit given* for assurance achieved against undeclared activities along acquisition paths, but that credit should not be so great as to open up real gaps in conventional safeguards (e.g., in detection of diversion of declared nuclear material).

2. POLICY CONSIDERATIONS

A fundamental question that would drive the substance of performance targets for detection of undeclared activities[†] is how one views the role of the IAEA with respect to discovering undeclared activities versus that of Member State intelligence services or other third parties, and accordingly how much IAEA effort should be assigned to the three state-level objectives.

There is on the one hand a view expressed by some observers³ that the real safeguards compliance threat is undeclared activities, and that in a time of limited resources the Agency cannot afford to devote as much effort as it has in the past to safeguarding

* The term “credit given” is used in this paper in the sense that if there is an assumption that a detection capability exists for undeclared elements of an acquisition path, that “credit” allows one to reduce the intensity of safeguards along the rest of the path. It does not relate to public statements by the IAEA.

[†] In this paper, the term “undeclared activities” should be understood to refer more broadly to undeclared nuclear material, undeclared nuclear activities, or both.

declared activities, especially in states with a strong record of cooperation and transparency.

On the other hand, some hold the view that the IAEA should not assume too great a focus on undeclared activities that could lead the IAEA to spend too much of its limited budget on intelligence-like activities without adding commensurate value.

So what is the right balance? What should the IAEA be capable of doing with respect to undeclared activities? We propose that the following considerations might help to form a consensus view:

- a) The IAEA's verification role with respect to detection of undeclared activities should be grounded in its unique access to information and locations that would not otherwise be available. In that light, we believe the IAEA should be cautious about devoting *in-field* safeguards resources to detection of undeclared activities detection away from declared locations, unless there are *specific leads* that it is in a position to pursue. Such *actionable leads*, when deemed credible by inspectors, might come from inspections at declared locations, from third parties, or from IAEA information analysis.
- b) With respect to *headquarters* activities, the IAEA should maintain a sound assessment of the state's nuclear-related activities and related technical capabilities, and it should conduct a thorough state-level acquisition path analysis, so that it has a sound basis from which to set timeliness and detection-probability performance targets for the detection of diversion and of facility misuse.
- c) Information analysis should occur a level sufficient to support assessment of the state's nuclear and nuclear-related activities in general (including the state's nuclear-related R&D, the status of its fuel-cycle expertise, and applicable technical-industrial infrastructure) and to identify such indications of undeclared activities as may be discernable from information analysis, especially in those areas of the fuel cycle identified through state evaluation as having a high priority for monitoring.
- d) In States with an Additional Protocol in force, Complementary access rights should be exercised regularly across the spectrum of AP elements, not only to prevent atrophy of those rights but also with an emphasis on clear objectives: to pursue questions and inconsistencies identified through field activities and information analysis, to improve knowledge of state capabilities in key fuel cycle areas identified through acquisition path analysis, and to deter use of declared sites for illegitimate purposes.[‡]
- e) Because some undeclared activities are inherently difficult to detect, the Agency should be realistic about the limits of its ability to detect any and all such activities, particularly those activities that are well hidden or small in scale.

[‡] In this view, the Agency's comparative advantage is in detecting and deterring undeclared activities not only at declared facilities but also (in states with an AP) at other declared locations that can reasonably be expected to be associated with nuclear activities and increasing the cost and difficulty for the state to conceal such activities.

Consequently, limited credit should be ascribed to these assurances in acquisition path considerations.

- f) The Agency must be able to assess and respond appropriately to questions and inconsistencies arising from State declarations (including exports reported by third parties), open sources, inspector data, or Member State input. This requires a robust capability to investigate and resolve any concerns that may arise about compliance with safeguards obligations. Targeted field missions, conducted under complementary access or other authority and supported by environmental sampling and field instrumentation, provide the optimal means for the IAEA to meet this goal.
- g) As a matter of appropriate resource allocation, the Agency should not pursue the unrealistic goal of routine standoff detection of undeclared nuclear activities away from declared sites through the use of highly sophisticated or “novel” technologies until and unless they are shown to be affordable and effective for IAEA safeguards use.

3. A PROPOSAL FOR THE STRUCTURE OF PERFORMANCE TARGETS FOR STATE-LEVEL OBJECTIVE A

To recapitulate what might be drawn from the above analysis:

- There are certain activities that the Agency should be performing, and capabilities it should maintain, in order to carry out what we view as its role in detecting undeclared nuclear materials and activities and in following up indications detected by third parties or revealed in credible open sources. These Agency activities should have limits and should seek to complement rather than displace third party measures.
- It is generally difficult or problematic to model safeguards effectiveness in addressing specific undeclared activities as a function of specific lists of activities undertaken; any results of such modeling will be highly uncertain.
- Therefore, the analysis underlying the design of a state-level safeguards approach (SLA) should not be too sensitive to any quantitative assessment of the expected detection effectiveness for undeclared activities. In particular, the SLA should not allow assessments of effectiveness for undeclared activities to result in gaps in effectiveness at declared locations.

The preceding discussion suggests that performance targets for undeclared activities should require the activities and guidelines referred to above, but that any estimation of the expected detection effectiveness should be coarse and should discourage the use of overly optimistic assumptions about detection capabilities to downgrade important detection capabilities at declared locations, particularly for steps that are close (in time) to the acquisition of weapon-usable material, such as enrichment or reprocessing facilities

or locations where unirradiated direct use material is processed or stored.[§] This in turn suggests a model where the input is a list of things the Agency needs to do, both at the state level and the global level, and the output (i.e., the measure of whether a given performance target has been met) might be as simple as pass/fail grades (Was the activity conducted? Did it provide any indication of undeclared activity?).

At the *global* level the Agency would have to maintain adequate technical capabilities in a number of areas, laboratory standards for particulate analyses, and so on.

At the *state level* the list of products – and activities needed to produce them – would have to include:

- A current model of the state’s fuel cycle and identification of acquisition paths;
- An assessment of the state’s technical capabilities;
- An assessment of the time and difficulty required for the state to establish and operate undeclared facilities necessary for certain acquisition paths.
- Adequate complementary access for states with an AP in force^{**},
- Adequate open source collection and analysis. Performance targets should call for broad monitoring of overall nuclear fuel cycle related R&D activities in the state as well as more focused monitoring of high-priority topics. Activities should include monitoring a broad set of media sources and nuclear trade publications, review of scientific and technical publications, and focused information collection and research on any key critical topics identified in acquisition path analysis. The required extent and depth of this activity will be greater for states with extensive nuclear and nuclear-related capabilities or where there already exist identified inconsistencies or other potential indications of undeclared activities.
- Resolution of significant anomalous conditions. Questions and inconsistencies identified in ongoing state evaluation should be pursued through use of available tools (asking questions of the state, focused open source collection and analysis, complementary access, environmental sampling, satellite imagery analysis, etc.).

Note that for the Agency to be able to take account of, and reduce routine activities based on, assurance gained by its activities to detect indications of undeclared activities, there has to be AP complementary access, and there should be no serious outstanding questions or inconsistencies. The SIR could report factually on accomplishment of these items.

Both in the case of complementary access and open source information analysis, it may be hard to provide hard quantitative criteria as to what is “adequate” and what is too much – a descriptive guidance statement would probably have to suffice. Certainly in the case of complementary access, any formula might well provoke objections that the Agency was acting “mechanistically or systematically” contrary to AP Article 4.a. Such

[§] The greatest potential for reduction in safeguards effort at declared locations would involve acquisition paths that are relatively time consuming and steps that are relatively removed from final acquisition steps.

^{**} “Adequate” is in the sense of section 2 point (d) above.

descriptive guidance could certainly be open, and would provide some level of transparency. The guidance could suggest that efforts be focused based on acquisition path considerations such as:

- *Whether acquisition path analysis indicates the path step is close in time to final acquisition on one or more relatively high plausibility paths* and whether detection of the path step would be critical to covering the paths it is part of. For example, monitoring of research publications related to uranium enrichment could be held to a higher standard than monitoring of research related to ore concentration in the state. Similarly, complementary access to look for evidence of undeclared reprocessing R&D might have a higher target than complementary access to look for undeclared conversion to UO₂.
- *Whether there are unresolved questions or inconsistencies* related to the path step. For example, if the Agency had noted the publication of research papers concerning improved methods for UF₆ production by a research institution in a state that had no declared plans or capability for UF₆ production or uranium enrichment, this might raise a question about the possible existence of undeclared activities related to UF₆ production or even UF₆ enrichment. Performance targets could be framed in a way that specifically calls for these questions or inconsistencies to be pursued, for example, through requesting clarification from the state, through complementary access to the research institution that published the work in question, and expanded information analysis related to UF₆ conversion and enrichment.
- *Whether the state has known or suspected technical capabilities related to the path step* (e.g., conversion of UO₂ to UF₆) that could enable it to implement the step without requiring a long lead time for necessary R&D and attainment of expertise and manufacturing infrastructure.
 - In the case of a state with little or no current capability in the fuel cycle step of interest, the performance target would focus on monitoring the status of any known early R&D activities and on being alert to (and following up) any indications of relevant undeclared R&D activities.
 - For a state with more substantial known capabilities—such as an existing or former known fuel cycle facility of a type appropriate for the path step in question—the focus instead would be less on early R&D and more on detection of activities related to construction and operation of an undeclared instance of that fuel cycle step. Monitoring of information would need to be more frequent, and response to detected indications more rapid, than for a state with less advanced capabilities.
- *Whether (and which) available measures could be adequately cost-effective in detecting the path step or in following up questions and inconsistencies.* The

feasibility of detection may depend strongly on whether specific indications have been identified that suggest where and how to look.

- In seeking to provide assurance about the absence of undeclared nuclear activities in the state as a whole, priority should be given to following up on *location-specific indications* as they arise, rather than to broad, undirected and open-ended efforts that may add little to the detection probability.

4. UNDECLARED-ACTIVITY PERFORMANCE TARGETS IN THE CONTEXT OF THE STATE-LEVEL CONCEPT

The next question is what the “output” of the performance target is and how it would be used; in other words, if the Agency performs the required activities, what credit is it given? The philosophy of safeguards under the SLC will be largely grounded in a concept of acquisition paths – which will contain undeclared activities as elements – and the IAEA’s ability to provide detection along those paths. Acquisition path elements for undeclared activities (e.g., undeclared enrichment of UF₆ to HEU) in states where these conditions were fulfilled could be given the label “increased assurance of the absence of undeclared activity,” and where they are not fulfilled, the elements would be labeled “no increased assurance.”^{††} These labels would be taken into account in setting necessary levels of effectiveness at declared facilities according to acquisition path considerations. As a consequence, states without an AP in force could have higher performance target values at declared facilities than would be the case if the Agency had the additional information and access provided by an AP. It is also reasonable that performance target parameters at declared facilities with less sensitive materials be less stringent than those with more sensitive materials, because there are more opportunities for detection along the undeclared elements of the path; however, according to the discussion above it would be important to make clear that “increased assurance” does not get interpreted as “high assurance” and hence the possibility of ineffective detection of diversion.

To illustrate how this might work for a state with an AP in force and all questions and inconsistencies addressed, it is helpful to look at an example. For acquisition paths beginning with diversion of declared natural UF₆, there would be paths that involve the path steps undeclared conversion and undeclared enrichment. If performance targets for these hypothetical undeclared path steps were met, the path steps would be labeled “increased assurance of absence.” That would not mean that one could abandon material accounting on natural UF₆, but it might mean that some of the goals for that accounting could be lower than for natural UF₆ in a state that had no AP, and hence no increased assurance.

There might be a third label that could be used in states where it was clear, based on a certain level of consideration, that some undeclared activities could be reasonably ruled out in light of the Agency’s assessment of the State’s level of technical expertise or technical infrastructure. In such case one might use a label of “implausible.” Clearly this

^{††} Recognizing that “increased” here is relative to a baseline assurance that is a function of the State’s technical capabilities and quality of information.

label should be used conservatively and with an awareness of the risk of clandestine foreign assistance.

The Agency should be able to assess trends in its own performance over time in order to determine whether budget or other constraints are affecting the credibility of its conclusions regarding Objective A.

5. CONCLUSIONS

The IAEA's Safeguards Department has made a considerable amount of progress in developing the State Level Concept, but some details appear to be still under development. As safeguards implementation in states evolves from facility-based approach of the 1991-1995 Safeguards Criteria and the modified facility-based criteria of Integrated Safeguards to more customized state-specific approaches, it will be important for the Agency to be able to evaluate for itself, and to communicate to member states, that safeguards measures have been planned on a sound basis and have been carried out effectively. Performance targets may play a helpful role in that regard. For safeguards undeclared activities, however, the issue of performance standards runs up against questions for which there are no purely technical answers. This paper has sketched out a concept for how performance targets for undeclared activities at undeclared locations could be formulated. In the future, it may be useful to look at how this general approach could be fleshed out and applied in case studies that would advance our understanding beyond abstract ideas.

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¹ B. Moran, J. Cooley, E. Pujol, "Making the IAEA Safeguards System Fully Information Driven," paper presented at the 33th ESARDA Annual Meeting, 16-20 May 2011, Budapest.

² J. Sanborn, D. Gordon, K. Bachner, *An Example of a Performance Target Guidance Document*, Brookhaven National Laboratory Report No. BNL-100995-2013-IR, July 2013.

³ See, for example, "Towards more effective Safeguards: learning hard lessons," former IAEA Deputy Director General for Safeguards Herman Nackaerts' keynote address at the opening plenary session of the 7th Joint Meeting of ESARDA and INMM, 17 October 2011, Aix-en-Provence.